

R E M A R K S

The Examiner is thanked for the courtesies he extended to the inventor, Mr. Adachi, to the applicants' representatives (Mr. Obika and Mr. Tanaka) and to the undersigned during an interview conducted on September 24, 2003.

The Examiner is thanked for returning with the June 4, 2003 Office Action a copy of applicants' Form PTO/SB/08A dated October 7, 2002. However, the Examiner's initials on said copy of the Form PTO/SB/08A are not set forth in the left column next to USP 5,523,050 to Lloyd et al. The Examiner is respectfully requested to return another copy of said Form PTO/SB/08A dated October 7, 2002 with the Examiner's initials in the left column next to all the cited publications.

The specification was amended to correct a minor clerical error.

The amendments to the claims involving the term "spherical" are supported in the specification on several pages, including pages 24, 30, 43, 44, 47 and 54.

The amendment to claim 1 and new claims 61 and 62 involving the cooling rate are supported in the specification on page 25, line 3; page 44, line 3; page 161, line 4; and page 170, line 5.

The amendment to claim 41 is supported in the specification on page 120, 6<sup>th</sup> line from the bottom.

New claims 58 to 60 are supported in the specification by the paragraph bridging pages 47 and 48.

New claims 63 to 65 are supported in the specification on page 181, lines 6 to 8.

New claims 66 to 68 are supported in the specification in the last paragraph on page 194.

New claim 69 is supported in the specification on page 25, lines 1 and 2.

Claims 1 and 6 were objected to for the reasons set forth in Item No. 2 at the middle of page 2 of the Office Action.

Claims 1 and 6 were amended to avoid the objections.

Claims 30 and 36 to 38 were rejected under 35 USC 112, second paragraph, for the reasons set forth in Item No. 4 at the top of page 3 of the Office Action.

Claims 30 and 36 to 38 were amended to avoid the 35 USC 112 rejection.

It is respectfully submitted that the present claims comply with all the requirements of 35 USC 112.

Prior to addressing the prior art rejection, applicants wish to discuss their invention in the context of the prior art.

As is described in the specification beginning on page 4 under "Background Information", there are various known methods for shaping semisolid metals.

One representative method is called a "thixo-casting method" which comprises the steps of stirring a molten metal at a temperature between the solidifying temperature and the liquidus temperature, to produce equiaxed crystals in the molten metal; cooling the stirred molten metal to a temperature lower than the solidifying temperature to produce a billet (solid bar); heating the billet to a temperature between the solidifying temperature and the liquidus temperature to produce a semisolid metal; and feeding the semisolid metal into a mold.

Another representative method is called a "rheo-casting method" which comprises the steps of stirring a molten metal at a temperature between the solidifying temperature and the liquidus temperature to produce spheroidized structures in the molten metal; and subsequently feeding the molten metal into a mold.

In summary, the thixo-casting method necessarily comprises the steps for manufacturing a billet from a molten metal having equiaxed crystals and heating the billet for feeding the resulting semisolid metal into a mold; whereas the molten metal

having spheroidized structures is directly fed into a mold in the rheo-casting method.

The prior art methods involved the forming of dendritic crystals that had to be ground into spherical grains by mechanical means (see page 49, lines 14 to 18 of the specification) or stirring had to be applied.

Applicants' claimed semisolid metal shaping method is an improved rheo-casting method in which spheroidized (non-dendritic) structures in the molten metal are directly produced by two steps, namely a first step for preparing crystal nuclei in the molten metal and a second step for producing primary spherical crystals from the crystal nuclei in the molten metal, while the molten metal is slowly cooled in an insulated vessel. Subsequently, the molten metal containing the produced primary spherical crystals is directly fed into a mold. The improved rheo-casting method according to the presently claimed invention is advantageous in that a semi-solid metal having uniform spheroidized structures can be continuously produced in a small period of time and with a small consumption of energy.

The independent claims that are presently being examined include claims 1, 11, 12 and 14. Claims 1, 11 and 12 are method claims for semisolid metal shaping, and claim 14 is an apparatus

claim for producing a semisolid forming metal. Claim 1 which is reproduced hereinbelow, describes the basic concept of the improved rheo-casting method according to the present invention.

"A method of shaping a semisolid metal comprising:

(a) feeding into an insulating vessel having an insulating effect (i) a molten alloy, having crystal nuclei, at a temperature not lower than the liquidus temperature of said alloy or (ii) a partially solid, partially molten alloy having crystal nuclei at a temperature not lower than a molding temperature,

(b) maintaining said molten alloy in said insulated vessel for a period from 5 seconds to 60 minutes as said alloy is cooled to the molding temperature at a cooling rate of  $0.01^{\circ}\text{C/s}$  to  $3.0^{\circ}\text{C/s}$ , thereby crystallizing fine primary spherical crystals in an alloy solution thereof containing a specified liquid fraction, and thereafter

(c) feeding said alloy into a forming mold for shaping said alloy solution under pressure."

Such cooling rate of  $0.01^{\circ}\text{C/s}$  to  $3.0^{\circ}\text{C/s}$  avoids the need for stirring.

Claims 1 to 15, 30 to 39 and 41 were rejected under 35 USC 103 as being unpatentable over EP 392,998 ("EP '998") in view of Adachi et al. USP 5,701,942 for the reasons set forth in Item No. 6 on pages 3 to 5 of the Office Action.

The following position is taken in the paragraph bridging pages 2 and 3 of the Office Action:

"EP '998 teaches the basic claimed method of shaping a semisolid metal, comprising: heating an aluminum alloy to a liquid status at a temperature of about 700°C; conveying the alloy onto an adjustable and tillable surface of a jig (cooling plate 2); collecting the semi-solid metal slurry (semiliquid aluminum alloy) in vessels; and forming casting component parts by conventional molding and die casting methods."

The Examiner's understanding with respect to the above position is correct. The method claimed in EP 392,998 is directed to an improvement of the conventional rheo-casting method. Apparently, the step of conveying the alloy onto an adjustable and tillable surface of a cooling plate is performed to produce the desired spheroidized structures in the molten aluminum alloy. Applicants' claimed method does not require such step.

The following was stated on page 4, lines 6 to 8 of the Office Action:

"EP'998 fails to teach the use of a holding vessel and crystal grain refiner for controlling fine primary crystals in a semi-solid metal slurry".

The above statement (admission) is correct. However, such statement does not address the special feature of applicants' holding vessel. Applicants' holding vessel is an insulating

vessel having an insulating effect which is able to slowly cool the molten alloy containing the crystal nuclei to establish a specified liquid fraction and produce the primary spherical crystals in the resulting liquid alloy. EP 392,998 does not teach or suggest the cooling rate of  $0.1^{\circ}\text{C/s}$  to  $3.0^{\circ}\text{C/s}$ , as recited in applicants' claim 1.

The following position is taken at the middle of page 4 of the Office Action:

"However, Adachi et al. (col. 4, lines 49+) teach the use of a holding vessel and crystal grain refiner in a method of manufacturing semisolid metal slurry for casting, comprising: pouring the molten metal including at least a portion of semisolid state (fine primary nuclei including Ti, B, Zn, Sr, Si, etc.) into a holding vessel heated by electric coil; and controlling the liquid-phase content and globular crystal size through heat treatment including heating temperature and holding time for the purpose of improving effective casting and enhancing cast mechanical property."

It is noted that Adachi et al. do not disclose a holding vessel heated by an electric coil.

The semi-solid metal processing method of Adachi et al. represents an improvement of the conventional thixo-casting method which necessarily requires manufacture of a billet. See Fig. 1 and the description of invention given under the Summary of the Invention beginning at column 2, line 20 of Adachi et al.

Accordingly, it is respectfully submitted that the Examiner's alleged combination does not have a sound basis because the rheo-casting method of EP 392,998 and the thixo-casting method of Adachi et al. are performed based on different concepts.

Applicants have carefully reviewed the disclosure of Adachi et al., but have failed to locate the description indicated by the Examiner.

The thixo-casting method of Adachi et al. comprises the step of cold casting of grain refining and billet forming; preheating the billet for spheroidizing; heating the spheroidized alloy for raising the temperature; and molding the resulting semi-solid alloy. There is no disclosure in Adachi et al. with respect to a vessel for preheating the billet and further heating the preheated alloy. The molds illustrated in Fig. 14 and Fig. 16 of Adachi et al. are employed for rapidly cooling the molten alloy therein to manufacture the desired billet of Adachi et al.

Even assuming *arguendo* that the Examiner's understanding with respect to the teaching of Adachi et al. is correct, the holding vessel of Adachi et al. indicated by the Examiner differs from the holding vessel of the presently claimed invention. More specifically, according to the Examiner's understanding, the holding vessel of Adachi et al. is a holding vessel heated by an

electric coil (which, as stated above, is not disclosed in Adachi et al.), which apparently heats the billet to convert it into a semi-solid alloy. In contrast thereto, the holding vessel of the presently claimed invention is an insulating vessel for slowly cooling the molten alloy containing crystal nuclei.

It is therefore respectfully submitted that applicants' claimed invention is not rendered obvious over the references, either singly or combined in the manner relied upon in the Office Action in view of the distinctions discussed hereinabove. It is furthermore submitted that there are no teachings in the references to combine them in the manner relied upon in the Office Action.

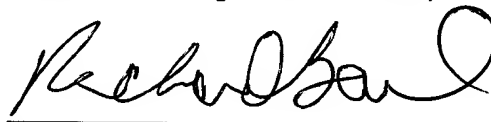
Reconsideration is requested. Allowance is solicited.

Enclosed is a check for \$144 for eight additional claims.

If the Examiner has any comments, questions, objections or recommendations, the Examiner is invited to telephone the undersigned at the telephone number given below for prompt action.

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Respectfully submitted,



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